Geographic Variation Pattern of *Larix olgensis*

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ABSTRACT On the basis of the data of provenance test for 10 years in the total natural range of *Larix olgensis* from 10 seeds collection sites, the geographic variation patterns have been made by means of canonical correlation analysis: (1) The basic variation patterns of growth characters is in vertical gradual change along the elevation gradient as principal, and gradual change along the latitude as supplement. (2) The Xiaobeihu provenance with low elevation and low equivalent latitude is the good gene resource center of *L. olgensis*. It has the genetic characters of rapid growth , high stability and fine timber quality. (3) The synthetical interaction between water and heat factors is the major factor to produce the variation of *L. olgensis* and the temperature is the principal one. (4) Among the genetic variations of geographic population characters, the variation of growth is the most obvious one, and it could be taken as the main character for provenance division. (5) By allocating the seeds from the low equivalent latitude region to the northern suitable afforestation areas, the greater genetic gain could be obtained.

Key words: *Larix olgensis*, Provenance, Geographic variation, Growth character

INTRODUCTION

Larix olgensis, with fast growth and high utilization value, is a main reforestation species in the northern mountain of northeast part of China. Due to its high ecological diversity in distribution area, long-time natural selection and genetic differentiation within species, some stable provenances with certain genetic structure have been formed. Also, there are great different production potential among geographic provenances of *Larix olgensis*. As a result of ignoring geographic variation among provenances of inter species and transferring seed utterly groundless from one place to another, it often has some heavy economic losses in forestry production. Therefore, twice provenance tests of *Larix olgensis*, in northeast part and east Neimeng Autonomous region of China, were carried out from 1978. The purpose is to find out the geographic variation among provenances, to divide provenance zone rationally and to utilize population difference effectively. In this paper, geographic variation pattern of Larix olgensis is studied on the basis of growth characteristics of 10-year-old provenance from the first provenances test.

MATERIALS AND METHODS

Distribution of Seed Collection Areas and Provenance Trials Based on net-square of latitude and longitude, mountain system in distribution area of this species, and criterion of international provenance test, ten seed collection areas were selected, such as Tianqiaoli, Helong, Baihe in Jilin province; Xiaobeihu, Baidaoshan, Muling, Jixi and Dahailin in Heilongjiang Province.

After that, ten provenances trials were established, according to the principle of provenance trail establishment in both of natural distribution area and introduction area of *Larix olgensis*. The location of those seed collection areas and provenance trials is shown in Table 1, in which Mao'ershan. (1) represents trial on dark brown forest soil; Mao'ershan.(2) represents trial on baijiang soil.

Design of Field Test Complete random block design with three replication was used in seeding nursing, and five replication, hundred plants per plot in two lines and spacing 1.5 m×2.0 m in the trials. Local provenances were adopted as control and protection lines.

Measuring Method of Sample Plants The

growth characteristics like seeding and tree height (H), ground diameter for seedling (D), diameter breast height ($D_{1.3}$) and volume were measured in this study. 30 plants per plot, which were selected in mechanical sampling, were observed in each autumn of nursery period. After planting in the field, the sample plants were selected every third plants just in one liner per plot. 10 plants were measured. It began to measure Diameter breast height when plants grew 1.5 m.

Data Processing Total data were divided by years and trials, and plant mean were calculated as basic data for the study. In order to meet the needs of several statistics method, some main hypothesis were made that (1)abnormal data cover high or low were tested by Smirnov giving up method and it would decide which one to be used; (2) missing values were replenished according to estimation of missing value in complete random block design; (3) kolmogorov-Smirnov test was done to determine all data's distribution.

Table 1. The location of seed collection areas and provenance trials

Seed collection area	Latitude (N)	Longitude	Provenance Trial	Latitude (N)	Longitude (E)
Tianqiaoling	43°34′	129°17′	Mao'ershan. (1)	45°20′	127°34′
Helong	42°30′	129°01′	Dongfanghong	45°07′	133°06′
Baihe	42°25′	128°08′	Linkou	45°16′	130°15′
Dashitou	43°19′	128°31′	Shihe	44°30′	129°08′
Xiaobeihu	44°01′	128°50′	Liangshui	47°10′	128°53′
Lushuihe	42°30′	127°48′	Jiagedaqi	50°24′	124°07′
Baidaoshan	44°00′	131°07′	Longjiang	47°27′	122°51′
Muling	44°52′	130°31′	Chaohekou	40°53′	123°54′
Dahailin	44°28′	129°48′	Fushun	41°50′	123°54′
Jixi	45°12′	130°50′	Mao'ershan.(2)	45°18′	127°31′

In order to explain some unreasonable variation forms, eliminate altitude influence and reflect real effect of latitude, an idea of equivalent latitude from Katariva Lindgren (1984) was used in this study.

Equivalent latitude = latitude + (altitude - 300)/ (200 or 140)

140 was used as denominator when altitude was over 300m; 200 was used when altitude was below 300m.

Statistics Methods Variance analysis, correlation analysis including partial and canonical correlation, trend surface analysis and cluster analysis etc. Were used in this research.

There are several steps as follows:

How to divide ecological forestation zone and select representative provenance trial Cluster analysis was used to divide new ecological forestation zone, in which trials were adopted as treatment and provenances as variable. In each zone, there should be no great interaction between provenances and trials. And then preventative trials were selected out according to the importance of the trials in each zone.

Characteristics selection with significant difference. Variance analysis was made to select some characteristics what had big difference among provenances in each trial. The purpose is to study geographic variation of characteristics among provenances.

Analysis of geographic variation trend Canonical and partial correlation analysis were done to study basic pattern of geographic variation of characteristics among provenances, in which there were tow groups divided, one is biological characteristics group, another is geographic variable group.

Study on chimerical and ecological basis of provenance variation By means of canonical correlation analysis between geographic variables and main climate factors, between biological characteristics and climate factors, it would find out the relationship between geographic variables and climate r factors, and also select some important climate factors that could cause geographic variation among provenances, as well as arrange those climate factor in order of relative importance.

RESULTS AND ANALYSIS

How to Divide Ecological Reforestation Zone and Select Representative Trials The results, by variance analysis to diameter breast height of 10-year-old provenances from nine trials, have shown that there are large interaction between provenances and trials. It states that data from one trial is not enough to study geographic variation of *Larix olgsensis*; and a comprehensive analysis to all trials is necessary to be carried out. Therefore, according to the similarity of growth characteristics of provenances from nine trials, four ecological forestation zones are divided by multi-factor variance analysis and cluster analysis. They are Longgangshan and Mudanjiang ecological forestation zone, as well as Songnen plain, Daxing'an Mountains and Xiaoxing'an Mountains Introduction zone (Table 2).

At the same time, four representative trials are determined in each four zone on the basis of importance of trial's location and condition. Chaohekou trials which separately stand for Daxing'an Mountains and Xiaoxing'an Mountains, Mudanjiang, Shongnen Plain and Longgangshan zones.

Geographic Variation of Growth Characteristics of *Larix Olgensis* **Relations between geographic factors and growth characteristics of provenances** The result by variance analysis

indicates that there exists great difference in growth characteristics among provenances to every trial, no matter what is in seedling or in young tree period (Table 3). Also, it can be seen from Table 4-5 that (1) almost the same pattern is displayed in growth difference among provenances, as continuous variation; (2) the seedling growth among different provenances in most trials. Increment is increasing from south to north, from high to low altitude. Latitude is a more important factor. There is a positive correlation between increment and latitude. This result looks abnormal in ecological point of view. But, a negative correlation is obtained after equivalent latitude used. The reason is that high increment in high latitude is often caused by low altitude, high temperature and longer growing, and vice versa.

Table 2. Division of ecological reforestation zone of *Larix olgensis*

Provenance Trial	Combined Analysis (I) (Flxp)	Cluster Result (I)	Combined Analysis (II) (Flxp)	Cluster resul t (II)	Combined analysis (III) (Flxp)	Ecological reforestation zone
Linkou		Linkou		Linkou		Mudanjiang zone
Shihe		Shihe		Shihe	1.650	
Maoer M.		Maoer M.		Mao'ershan.		
Dongfanghong		Dongfanghong	1.762**	Dongfanghong		
Fushun	3.928**	Fushun		Fushun	1.490	Longgangshan zone
Chaohekou						
Longjiang		Longjiang		Longjiang		Songnen Plain zone
Liangshui		Liangshui	6.621**	Liangshui	1.772	Daxing'an Mountains and Xiaoxing'an
Jiagedaqi		Jiagedaqi		Jiagedaqi		Mountains Zone

By using canonical correlation analysis between growth characteristics in young trials and geographic factors, it reveals a basic variation pattern to growth characteristics of the provenance. In Longjiang and Chaohekon trials, there are close correlation for canonical variable of the first set, in which the most effective factor is altitude, and then equivalent latitude. To rely on altitude changes first while having variation along with latitude secondly have been a basic variation pattern of growth characteristics of the provenances. A further prove have been made by partial correlation analysis (Table 3).Provenances in lower altitude and equivalent latitude grow faster than those in higher altitude and equivalent latitude.

Table 3. Variance and correlation analysis of growth characteristics in seedling period

Representation Trial	F value	Variation Range (cm)	Correlation analysis: Latitude	Longitude	Equivalent Latitude	Altitude
Liangshui (2H)	3.3819*	36.0-43.5	0.3736	-0.4668	-0.4125	-0.2508
Chaohekou (2H)	4.7908*	41.8-54.6	0.5568^{Δ}	0.2639	-0.5920	-0.5517
Longjiang (1H)	23.0118**	4.30-10.0	0.5947^{Δ}	0.3650	-0.4762	-0.4867
Mao'ershan. (1H)	1.3570	14.74-18.47	0.6959*	0.5867^{Δ}	-0.3928	-0.5509^{Δ}

Table 4. Variance and correlation analysis of growth characteristics in young trials

Representative Trial	Trial	F value	Variation Range	Correlation analysis: Longitude	Latitude	Equivalent latitude	Altitude	Partial correlation Analysis: Longitude	Latitude	Equivalent Latitude	Altitude
	10H	6.0665**	4.00-5.29	-0.2471	-0.3363	-0.0527	0.1900	-0.0763	-0.3363	-0.2886	-0.1539
Liangshui	10D	7.6921**	3.62-5.87	-0.2446	-0.2335	-0.0119	0.1489	-0.1915	-0.2335	-0.1390	-0.0156
	10V	7.3405**	0.002027-0.007693	-0.3615	-0.3339	0.0069	0.2282	-0.3124	-0.3339	-0.1955	-0.2600
	10H	5.2807**	3.49-4.81	-0.1058	0.1689	0.0968	-0.0322	-0.3723	0.1689	-0.3128	-0.4011
Mao'ershan	10D	5.0850**	3.30-5.15	-0.0845	0.2413	0.1776	-0.0314	-0.3787	0.2413	-0.4309	-0.4549
	10V	5.9275**	0.001998-0.005562	-0.5439	-0.0367	0.4103	-0.4619	-0.3770	0.2567	-0.2187	-0.4817
	10H	12.7635**	4.80-6.30	0.3875	0.6182^{Δ}	-0.4330^{Δ}	-0.6795*	-0.7280*	0.6182	-0.5329	-0.8322**
Longjiang	10D	13.1563**	4.64-6.53	0.5891^{Δ}	0.5650^{Δ}	-0.6230^{Δ}	-0.7906**	-0.3864	0.5654	-0.1092	-0.6372^{Δ}
	10V	12.208**	0.005226-0.01161	0.4100	0.6107^{Δ}	-0.4287	-0.6750*	-0.6470^{Δ}	0.6107^{Δ}	-0.4709	-0.7821*
	10H	4.8734**	3.22-5.02	0.0679	0.3104	-0.3467	-0.4166	-0.7234*	0.3104	-0.2679	-0.7334*
Chaohekou	10D	3.8850**	2.26-4.46	0.0968	0.4028	-0.2521	0.4206	-0.7254*	0.4028	-0.4591	-0.7673*
	10V	3.9877**	0.001029-0.004683	0.1000	0.3533	-0.2798	-0.4043	-0.6479^{Δ}	0.3533	-0.3261	-0.6867

In order to know this geographic variation directly, trend surfaces analysis has done (Fig.1). A clear change of provenance growth with equivalent latitude and altitude gradient has been seen again.

Table 5. Canonical correlation analysis between growth characteristics of young tree and geographic factors

	Liangshui		Mao'ershan		Longjiang		Chaohekou	
Biological	Coefficients for canonical valuables of the first and second set		Coefficients for canonical variables of the first and second set		Coefficients for trait equation of variables of the second set		Coefficients for trait equation of variables of the second set	
	λ_1 0.8504	λ_2 0.6233	λ_1 0.8362$^{\Delta}$	λ_2 0.5256	λ_1=0.9226*	λ_2 0.7940	λ_1 0.9213*	λ_2 0.7851
Characteristics	Coefficients for trait equation of variables of the first set		Coefficients for trait equation of variables of the first set		Coefficients for trait equation of variables of the first set		Coefficients for trait equation of variables of the first set	
	U_1	U_2	U_1	U_2	U_1	U_2	U1	U_2
10H	-2.4278	3.2732	-3.0657	3.4317	-2.7927	2.7628	-6.1658	1.9245
$10D_{1.3}$	6.1452	1.1383	3.6570	-3.2785	1.05189	-2.0214	3.2654	-2.5836
10V	-4.2047	2.2823	0.7267	0.6302	0.99428	-1.4583	2.5544	-0.2414
Geographic	Coefficients for trait equation of variables of the second set		Coefficients for trait equation of variables of the second set		Coefficients for trait equation of variables of the second set		Coefficients for trait equation of variables of the second set	
factors	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2
Equivalent latitude	1.1420	-0.09959	1.4917	-0.7257	-0.9524	0.6336	1.1198	-1.1721
Longitude	0.44169	2.1113	-1.1594	-1.2223	1.8757	-0.8095	1.6512	1.0055
Altitude	-1.1120	-1.0020	-1.7993	0.02584	2.8350	-0.3190	2.2431	0.8136

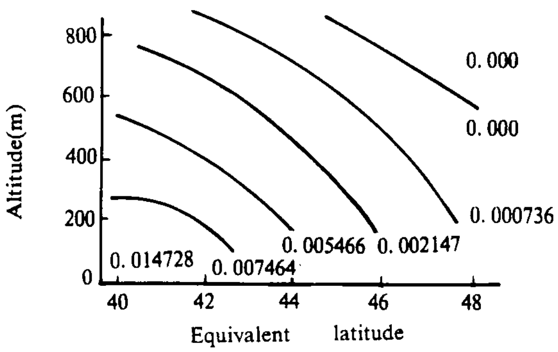

Fig. 1 Two way trend surface pattern of mean volume of provenances in 10 years old.

In Liangshui and Mao'ershan Trials, there are weak correlation (in 0.1 level) among both of canonical variables of the first and second set, but the variation trend is almost the same.

The climatical and ecological basis of provenance variation The result from canonical correlation analysis indicates that there is great significant relations between geographic variables and climate factors, no matter what is in the canonical variables of the first set or in the second set (Table 6). In the canonical variables of the first set, altitude plays an important role in geographic factors, and mean temperature in Janwary, ≥10 ℃ accumulated temperature and frost free season in climate factors. In the second set, both of altitude and longitude are major factors to affect the canonical correlation coefficient. There are close relations between altitude gradient and main temperature factors. This is why growth variation of the provenances is bound to follow the altitude changes.

Table 6. Canonical correlation analysis between climate factors and geographic factors

Coefficient for canonical variables of the first and second set		
	λ_1 0.9986**	λ_2=0.9871*
Climate factors	Coefficients for trait equation of variables of the first set	
	U_1	U_2
Annual mean temperature	0.61648	1.58557
Mean temperature in Jan.	-1.26374	-0.53882
Mean temperature in July	0.35393	1.885753
≥10 ℃ accumulated temperature	-1.01803	-3.28872
Annual precipitation	-0.15453	0.33672
Frost-free season	1.29440	4.1.306
Obsolete humidity	-0.35929	-0.23462
Relative humidity	-0.23923	1.46358
	Coefficients for trait equation of variables of the second set	
	V_1	V_2
Equivalent latitude	0.69764	0.53472
Longitude	-0.60243	2.23542
Altitude	-1.44285	2.38447

Taking height growth of 10-year-old provenances as dependent variable, and climate factors as independent variable, stepwise regression analysis is used to study how growth characteristics of provenance are affected by water-heat factors, and also to select several climate factors for passage analysis, such as annual mean temperature in January, absolute humidity, frost-free season and precipitation. The result shows that annual mean temperature, ≥10 ℃ accumulated temperature and annual precipitation are the most important

factors to provenance growth, and the next are frost-free season, mean temperature in January and obsolete humidity interaction. In addition, it can be seen from geographic variation of the provenances that there is high adaptability between geographic populations of *Larix olgensis* and dry-wet as well as cold-warm factors (Table 7).

Geographic Variation of Wood Characteristics

According to reports, there are significant differences in some wood characteristics among provenances for many species, not only among trails, but also among samples in different age, especially in the early age.

The result from provenance test of *Larix olgensis* shows that (1) there is significant variation in some wood characteristics among the provenances from different trails, such as trachied length, trachied diameter, ratio between trachied length and diameter, width of growth ring and late wood percentage and so on; (2) In Liangshui and Chaohekou trails there is no great difference in wood hardness among the provenances, but the result is contrary in Maoer M. Trial. That means it is difficult to get higher genetic improvement in wood hardness because genetic variation in this trait is not stable in younger age (before eight years old); (3) No big difference in wood air-dry density among the provenances exists, so it is impossible to do early selection in this trait.

Table 7. Canonical correlation analysis between growth characteristics and climate factors

	Chaohekou			Longjiang		
	Coefficients for canonical variables of the first and second set			Coefficients for canonical variables of the first and second set		
	λ_1=0.9989**	λ_2=0.9966	λ_3=0.9419	λ_1=0.9949	λ_2=0.9466	λ_3=0.8194
Climate factors	Coefficients for trait equation of variables of the first set			Coefficients for trait equation of variables of the first set		
	U_1	U_2	U_3	U_1	U_2	U_3
Annual mean temperature	7.73303	7.73303	3.81626	-0.94550	2.05239	4.90151
Mean temperature in Jan.	-1.01408	-1.01408	-3.52435	1.86696	-1.38536	-2.29069
Mean temperature in July	4.92829	4.92829	-1.15478	2.78391	0.54889	-0.11556
≥10 ℃ accumulated temperature	-11.6437	-11.6437	-1.37303	-2.67536	-1.26475	-3.75571
Annual precipitation	1.16886	1.16886	0.23721	-1.65870	0.09914	1.57115
Obsolete humidity	0.39148	0.39148	0.01721	0.16195	-0.19818	-0.41934
	1.90235	1.90235	-0.64835	-0.05307	-0.54810	1.13980
Frost-free season	-0.43405	-0.43405	-0.64835	-0.28938	-0.49078	0.47205
Biological characteristics	Coefficients for trait equation of variables of the second set			Coefficients for trait equation of variables of the second set		
	V_1	V_1	V_2	V_1	V_2	V_3
10H	-1.60940	-1.57636	6.19390	3.41639	-2.29773	3.25550
$10D_{1.3}$	-1.59286	-1.18850	-4.29325	1.03982	-2.03910	0.38327
10V	-2.44688	3.43747	-1.92597	3.19203	-0.03005	-3.13331

Table 8. Geographic variation in wood characteristics among provenances

Preventative trial	Statistics	Trachied length	Trachied diameter	Ratio between trachied length and diameter	Width of growth ring	Ratio of late wood	Wood hardness	Air-dry density
	F value	2.72*	11.41**	5.76**	2.33	7.45**	1.69	1.14
Liangshui	Variation coefficient	20.7	19.9	26.8	22.2	28.7	19.9	7.6
	Variation range	1343-1774	20.7~36.6	51.7-81.5	3.52-4.61	11.42-22.75	397-470	0.451-0.48
	F value	7.17**	15.79**	5.51**	3.57**	2.67*	0.91	0.57
Chaohekou	Variation coefficient	18.9	20.00	26.8	17.7	24.3	18.4	8.5
	Variation range	1345-1936	20.6-31.2	59.7-82.8	2.70-4.53	12.56-15.11	330-379	0.429-0.458
	F value	6.63**	5.71**	3.18*	4.30**	6.50**	8.25**	1.74
Mao'ershan.	Variation coefficient	19.2	23.7	30.3	22.2	30.00	21.9	8.7
	Variation range	1821-2385	25.2-32.6	68.1-86.8	3.64-5.23	12.35-16.48	370-515	0.451-0.497

Results from some experts demonstrated that plynotype variation in wood characteristics has obvious relations with provenance location. In this research, wood characteristics and geographic factors are used to make canonical correlation analysis (Table 9). The correlation coefficient is λ_1=0.9877** (Liangshui trial) and λ_1=0.9921** (Chaohekon trial)respectively in the canonical variables of the first set, and no relation ship in the second set. Since the components, so it may say, the trachied traits are controlled by both of longitude and

equivalent latitude. The trachied length is longer, and the trachied diameter is smaller where equivalent latitude is lower and longitude is to the east.

Table 9. Canonical correlation analysis between wood characteristics and geographic factors

	Chaohekou			Liangshui		
	Coefficients for canonical variables of the first and second set			Coefficients for canonical variables of the first and second set		
	λ_1=0.9921**	λ_2=0.9056	λ_3=0.8215	λ_1=0.9877**	λ_2=0.9141	λ_3=0.5798
Wood characteristics	Coefficients for triat equation of variables of the first set			Coefficients for trait equation of variables of the first set		
	U_1	U_2	U_3	U_1	U_2	U_3
Trachied length	-2.36498	0.21199	4.3003	-0.21331	0.09614	-2.15445
Ratio between trachied Length and diameter	2.87067	1.29045	-5.23035	-1.60960	-1.05421	6.13770
Trachied diameter	2.22913	1.43862	-5.45698	-0.94062	-1.80767	7.44979
Wood hardness	0.32683	-1.22793	1.26238	-0.33688	-0.99545	1.83310
Rate of late wood	0.07875	0.46404	0.20794	0.34894	0.06912	0.65633
Width of growth ring	-0.72214	-1.79171	0.96421	0.11238	0.21868	0.09430
Air-dry density	0.32508	0.56339	-0.50878	0.73426	0.95927	0.26915
Geographic factors	Coefficients for trait equation of variables of the second set			Coefficients for trait equation of variables of the second set		
	V_1	V_2	V_3	V_1	V_2	V_3
Longitude	1.31578	-0.21795	1.79405	-0.62721	-0.15495	2.14009
Latitude	0.98696	1.22255	2.39676	-0.70075	1.50274	-0.24263
Altitude	0.77489	-0.68932	-1.31626	-0.20258	-1.68373	2.31024

Besides, trachied traits are also affected by climate factors, especially obsolete humidity and precipitation. The lower obsolete humidity and precipitation it is, the better the traits are improved genetically.

Genetic Variation of Other Characteristics

Variation of thousand-seed weight and germination rates of the seeds There is significant difference in thousand-seed weight and germination rate of the seeds among the provenances. The thousand-seed weight is controlled by geographic factors, and increases from south to northwest to east as well as high altitude to low altitude gradually. Seed germination rate has some correlation with equivalent latitude only (r= -0.4302).

Variation of phenological characteristics

Normally, there is difference in phenological rhythm among provenances, particularly growth characteristics. In this study, some phenological traits are measured, for instance terminal bud forming, bud expanding, leaf developing and changing yellow, as well as complete falling and so on. The result by correlation analysis indicates that it has clearly negative correlation between geographic factors and bud forming. Bud expending as well as leaf developing time, and positive correlation between geographic factors and leaf falling time. The further study is done by taking terminal bud forming as representative trait. It shows that correlation coefficient between preventative trait and longitude, equivalent latitude as well as altitude are -0.9161**, 0.6656* and 0.8611*, in which longitude is a leading factor to affect the trait's variation. In a certain condition of equivalent latitude, there are earlier bud expanding and leaf developing time, longer annual growth period, as well as later terminal bud forming and leaf falling time, with centre to east in longitude, centre to south in latitude and low altitude. It can be seen from Fig.2 that genetic differentiation of terminal bud forming trial, affected directly by longitude, is divided into three types as follows: (1) early bud forming type (Lushuihe, Baihe and Dashitou provenances); (2) late bud forming type (Jixi, Baitoushan, Muling and Tianqiaoling provenances); (3) middle bud forming type (Xiaobeihou, Dahailin provenances).

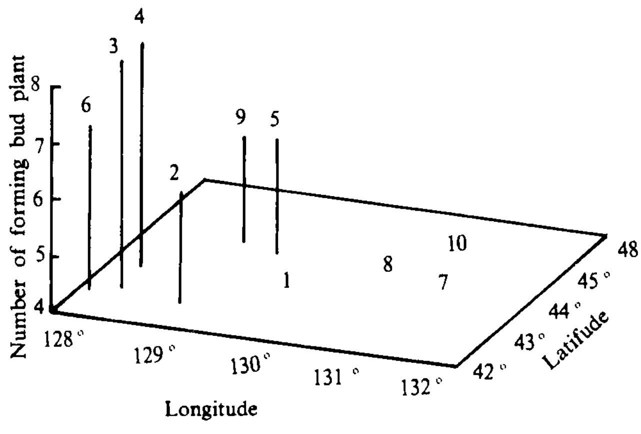

Fig. 2 Geographic variation of phenological characteristics

1. Tianqiling 2. Helong 3. Bihe 4. Dashidoou 5. Xiaobeihu 6 Lushuihe 7. Baidaoshan 8. Muling 9. Dahailin 10. Jixi

CONCLUSION

A basic variation pattern of *Larix olgensis* is a continuous variation, that relies mainly on altitude gradient while making latitude subsidiary. Water-heat factors are important factors to the geographic variation among the provenances, especially temperature.

In wood characteristics, there is great potentialities to make genetic improvement to trachied traits because big variation exists among the provenances, but not to wood hardness and air-dry density.

Variation in phenological characteristics like terminal bud forming time are influenced by longitude. Also, three phenological types are divided as follows: early, middle and late terminal bud forming types.

Since there is a big growth variation among different provenances, growth characteristics may become a main basis in the future provenance division and selection.

Variation in the thousand-seed weight among the provenances is controlled by geographic factors, and an increasing trend is presented in this trait from south to worth, west to east and higher temperature where provenance is, the heavier the thousand-seed weight is.

Geographic variation of *Larix olgensis* has close relationship with climate changes, such as dry-wet and cold-warm factors. Temperature plays an important role to growth variation among the provenances, in which ≥10 ℃ accumulated temperature is a leading factor, and then annual mean temperature, mean temperature in January, obsolete humidity, precipitation and frost-free season in turn.

Xiaobeihu provenance, located in low altitude and equivalent latitude place, is a rich center for good gene sources. This provenance has high increment, good stability, strong resistance and better wood characteristics.

In distribution area of *Larix olgensis*, it is possible to get higher genetic gain when to transfer seeds from low equivalent latitude to high equivalent latitude.

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